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Retention of Text Information by Grade, Ability, and Study

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Short Title: Retention of Text

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ABSTRACT

This study describes immediate and delayed text recall characteristics of good and poor readers at grades five, eight, eleven, and college. Two science and social study passages were selected from texts used at each grade. Immediately after reading and recalling each of the passages, one of four study conditions was administered: no study, think, outline, or combined think and outline. Eight to ten days later delayed recall was taken with the passage titles as cues. The measures used were reading time, study time, order of recall, and total and hierarchical proportions of propositions recalled. Good readers recalled more text propositions and better maintained text input order than did poor readers. Amount recalled did not increase by grade, but there was an increase by grade for able readers in retention and in order of recall. Both ability groups recalled more of the high level propositions than low level. Studying improved retention over no study. Good readers spent slightly more time in reading and studying than did poor readers, and the good readers' use of thinking time was effective in increasing amount retained per time spent over that of the no study condition.

INTRODUCTION

These studies describe the recall of school text information by good and poor readers at grades five, eight, eleven, and college. The effects of study versus no study on the retention of text information are also examined. Text recall findings related to developmental changes and to reading ability are discussed first.

Text Recall

A common finding is that amount of text recall increases with age (Danner, 1976; Brown & Smiley, 1977; Mandler & Johnsr, 1977; Mandler, 1978; Waters, 1978; and Mandler & DeForest, 1979). All of these studies used the same passages for the different age groups so that passage content could be controlled. The content of the passages is generally quite simple, supposedly within the knowledge structure of the youngest subjects sampled. The increase in recall by age may simply indicate that older students have more prior information on the passage content and do not have to rely as much on the text statements.

Passages selected from texts used at specific grades may compensate for the differences in prior information about the content by age. School text evaluations generally include an assessment of the content in comparison to estimates of the knowledge level and experiences of the intended students. If the content estimates are accurate, then an eleventh grade text should be as difficult for eleventh grade readers as a fifth grade text is for fifth grade readers, and recall comparisons can be made across grades.

The assumption of comparable text difficulty is questionable, for texts serve different purposes at different grades. Content readability is a more important criterion at the younger grade levels than it is for high school

and college texts, where the major selection criteria become the course objectives. In other words, equal increases in difficulty of content by grade level are not likely; college texts may be much more abstruse. But the recall and retention results will describe performance on curricular materials used in the grades tested rather than passages which would only be appropriate for instruction in the early grades.

The free recall data from the Cole, Frankel, & Sharp study (1971) indicate that young children have equivalent memory to older subjects for most recent list items. Performance is poorer for earlier list items, suggesting that rehearsal or structuring strategies are not used as much by young subjects. This finding suggests that if the passages are of comparable difficulty for the grades tested, there should be no difference in amount of immediate recall by grade though there will be differences in the amount retained over time.

Better readers recall more than their peers (Berger & Perfetti, 1977; Tierney, Bridge, & Cera, 1978-79; Evans, 1978; Drum, 1978). Good readers read more and thereby learn the more formal structure of writing (Olson, 1977). They generally read faster and thus have time to recognize what is said and to either concentrate on the conceptual structure or simply to re-read the material.

However, partitioning subjects on reading ability across grades does not produce similar skill level groups, nor does it even mean that the divisions within grades are similarly disparate from grade to grade. The expectations for good reading change with level of schooling. The instruments used to measure reading ability differ over grade changes though not in systematic ways (Drum, Calfee, & Cook, 1981). A fifth grader at the 26th percentile on a standardized reading test appropriate for the upper elementary grades has

different skills than an eleventh grade reader at the 26th percentile on a secondary test. College students classified as poor college readers generally come from the average percentile ranks in high school (Hunt, Lunneborg, & Lewis, 1975).

The patterns of the recall differences by ability within grades are of interest. Are there fewer differences at the college level where the reading ability differences are smaller? Supposedly the gap between good and poor readers increases with grade in school. If so, will there be bigger recall differences at eleventh grade than at fifth?

Structure of Recall. A second finding exemplified in the Brown & Smiley study (1977) is that all the subjects, grades three through adults, recalled the major ideas after listening to the stories twice. The majority of propositional recall studies after exposure to passages have also found that superordinate ideas are reported more often than subordinate (Kintsch & Keenan, 1973; Kintsch, 1974; Meyer, 1977; Waters, 1978). These studies either used college readers or asked the children to listen to stories. Tierney, Bridge, & Cera (1978-79) found that third grader readers showed no preference for major versus supporting idea units. Thus preference by children for the top-level structure may be due to the listening situation, where the subjects received the stress, pause, and pitch cues of the oral presentation.

On the other hand, many major ideas are presented at the beginning of a passage, and some portion of these ideas are repeated in supporting details until a transition is made into a new topic. The iteration of arguments whether in the same form or an anaphoric representation is a necessary condition for coherence (Halliday & Hassan, 1977). Children could recall the major ideas because of their repetition within the text without consciously knowing

the idea's importance in the conceptual structure. They could read only the first few sentences of passages and recall at least some major ideas without recognizing the organizational importance of major ideas to specific supporting details.

Brown and Smiley (1977) found that only adults were able to appropriately rate importance of story ideas. Even seventh graders could only recognize the most important and the least important ideas. Danner (1976) used two passage organizations: twelve sentences clustered into three topics of four sentences each and an interleaved sentence order without topic clusters. He found that most of his elementary subjects could not provide reasons why the non-clustered organization was harder. From the evidence considered, readers of all ages and at different ability levels are most likely to remember the major propositions of the text. The question still remains whether such recall is a sign of cognitive skill or an unconscious reaction to characteristics of texts.

Memory for text is an abstractive process where eventually only a conceptual skeleton remains that could represent many different texts that addressed the same topic from the same point of view. Many ideas that were recalled immediately are forgotten, but the propositions mentioned at delayed testing are usually ones recalled earlier and are generally the major ones (Meyer, 1975; 1977; Goetz & Armbruster, 1980).

The problem is that major ideas encompass the subordinating details and often present only general knowledge. Such ideas can be remembered as a vague recollection that one has read or heard something about the topic, for example "automobile engines work" or "an explorer came to America." The details of the time, the place, and what the explorer discovered or how the

engine works contain the information which may add to knowledge. If the surface structure attributes of the passage--the subordinate details, the input order, the same lexicon--are not represented in recall or retained over time, then it is likely that the passage information was not assimilated. Or, as Bower (1978) states, "Superior memory seems to be an incidental by-product of fully understanding a text." (p. 212)

Study Effects

The effects of study upon delayed retention of passage information are examined to see if the tendency to abstract the passage into general ideas will be counteracted. The question asked here is whether other specific text attributes, such as the subordinate details, the original lexicon, and the input order will be more likely to be retained after study. The second question examined is whether the influence of immediate recall upon retention will be diminished. If the readers recall only propositions mentioned immediately after reading, then study activities do not alter the reader's original evaluation of what was important within the passage. To study effectively, according to Dansereau (1978), the student must know whether performance at immediate recall was an appropriate response so that study time can be used to re-organize memory for missing information. But, as Brown (1978) notes, many students cannot assess their own performance. Improving one's learning of text information requires a knowledge of text structure as well as an evaluation of original recall performance. If the students cannot evaluate the concept structure of texts, then studying should not aid their delayed performance. Instead their study efforts will be dispersed over the entire text and subsequent retention will exhibit a list structure where isolated items are recalled, but the relation to text structure will be at best

fortuitous.

Study Conditions. Four study conditions were selected: (1) no study, (2) think, (3) outline, and (4) think and outline. No study is used as a baseline against which to determine the effects of study generally. The activity that is of most interest is thinking about the text with it in hand after performance in immediate recall because this activity most simulates self-initiated study sessions. The time that the students choose to take for thinking is also important. The questions examined are whether the better readers will take more time to study than less able students, and whether the additional time spent with the text will counteract the tendency to abstract propositional recall to major ideas.

Thinking is an activity that cannot be directly evaluated. Outlining is included so that there can be some measure of the quality of the study activity. Also, outlining is a form of note-taking which provides an external aid for review and requires obvious subject participation, conditions which have been found to improve retention in secondary students (Schultz & DiVesta, 1972). However, the difficulties that younger children can have in the physical act of inscribing could be counterproductive for the outline condition. Most of their resources might be needed for writing with little left over for attending to the text information. Thus, the final condition, where the subjects think first and then outline, was added to determine the effects upon the quality of the outline as well as upon delayed retention.

METHODS

Subjects

Sixteen subjects at each grade were selected according to the following procedures. Three teachers in grades five and eight were asked to divide their

students into good, average, and poor readers. Subjects were then randomly chosen from the good and poor reading groups. In the senior high school, counselors were asked to make these decisions because they were more likely to be familiar with the students' total academic records. The reading comprehension test scores for the current year also were used to provide a standard performance measure. However, the test scores were not available until after the experiments had been conducted, and in the eleventh grade sample were not available to the experimenter at all. Instead, the counselors stated that they had only selected students at or above the 90th percentile or below the 35th percentile.

As a result of the missing scores, performance on the practice passage was also used to select students. If the student could not recall the practice passage, then the experimental session was continued so that the student would not feel left out, but the data were not used in subsequent analyses. The intent was to test good and poor readers at various grades, but they had to be able to read sufficiently to do the task. Four students at fifth grade and two at eighth grade had to be replaced.

For the college sample, 80 undergraduates were given a Nelson Denny test in an half-hour session, and the raw scores were used to partition the sample into two groups separated by at least ten points. Random selection from each college group was then made. The college students received credit in a psychology course for their participation. The school age students received nothing, but seemed eager to participate. There were no problems in obtaining parental permission.

As seen in Table 1, the standard deviations are larger for the poor fifth grade readers than for other groups. The elimination of four subjects

Insert Table 1 about here

resulted in their replacement by better readers. There is not as great an ability variation in the college sample. This was expected for poor readers are not likely to attend college (Hunt, Lunneborg, & Lewis, 1975). The college samples instead represent average and good young adult readers.

Materials

To explore the retention effects, two science and two social study passages were selected from texts used in the public schools at each grade level. None of the texts were used in the particular schools that the subjects attended. Both science and social study passages were selected in order to sample expository texts from different disciplines. The passages were controlled for length, but not for content difficulty or literary quality. The intent was to try to determine effects of study on materials currently used by similar age and ability students in other schools. This naturalistic approach has the drawback of providing sources for variance that cannot be explained. Also, passages are nested in grades, so comparisons across grades for the same text information is not possible. On the other hand, the total amount of recall may be a more reliable estimate of the subject's typical performance on school subject passages than estimates based on materials suitable for the youngest reader.

The passages were analyzed into propositions (Turner & Greene, 1977), and then hierarchical clusters of information were established as outlined by Kintsch and van Dijk (1978). Certain passages had numerous hierarchical levels, but these were collapsed into three roughly equivalent groups: Group I (level 1), Group II (level 2), and Group III (levels 3 and beyond).

A sample of the passage scoring procedure is provided for the first two sentences of Resistance, an eleventh grade science selection:

"In electrical heating devices, such as grills, toasters, and flatirons, the actual heating element consists of high resistance wire or ribbon, usually made of an alloy of nickel, chromium, and iron. Such an alloy provides the necessary resistance in a compact space and does not melt or oxidize very much at the high temperature attained."

The syntax is quite complex. A long adverbial prepositional phrase describing the location of the element and examples of the locations is followed by a main surface clause which contains three clauses and three modifiers. The last participial phrase describes the sources for the wire and ribbon. The second sentence expands on the qualities of the alloy with two predicate phrases which relate to the title and to an explanation of the high resistance qualities of the wire and ribbon.

Insert Table 2 about here

The analysis starts with the first two word relationship, the locational phrase "in devices", and proceeds in passage order rather than the clausal order described in the Turner and Greene report (1977). However, the syntactic predominance of independent clauses was used in assigning propositions to hierarchical levels along with argument repetition. The fact that the ribbon was made by some unknown agent is a repetition of the existence of the wire and ribbon (1.10 and 1.12), so propositions 1.17 and 1.18 are lower in the

hierarchy for they repeat old information. Proposition 1.25 tells that the source for the resistance of the wire and ribbon is the alloy and thus provides new information, so it is raised to the same level as the major definitional propositions. Hierarchical level decisions were determined by both syntactic staging (clausal structure) and concept load (new versus old or elaborative information). Because of the occasional conflicts between the syntactic and conceptual decision rules for the hierarchical scoring, agreement only averaged .70. The principal investigator's judgments were used.

The passage characteristics by grade shown in Table 3 indicate that

Insert Table 3 about here

number of words, number of propositions, and proportional group hierarchies are roughly equivalent, and that sentence length and number of syllables per word increase with grade. Again, it must be stressed that the familiarity and interest values of the passage contents have not been addressed. For grades five, eight, and eleven, two teachers judged the content at each grade level on a four point scale: highly typical, typical, somewhat untypical, and completely untypical of materials used in their classes. Only passages that were judged highly typical or typical by both teachers were used. The only changes made in the passages were deletions of words or phrases that referred to preceding or subsequent passages.

Procedures

The subjects were told they would be asked to tell everything they could remember that the author said in the passage immediately after reading and

again about a week later. Each subject was tested separately in a quiet room at the schools. Their oral recall responses were taped and their reading and study times were recorded. The subjects read the passage, turned it over, and recalled it immediately afterwards from memory. If the passage was assigned to a study condition, the passage was returned for this activity.

Since the intent was to simulate self-study activity, no specific directions were provided. The subjects had as guidance only their own performance at immediate recall and directions to find the most important ideas and related supporting details for each passage. The instructions for all study types were the following:

What is the most important idea?

What support does the author give for this idea?

What is the second most important idea?

What support does the author give for this idea?

What is the third most important idea?

What support does the author give for this idea?

The general procedure was read, recall, and review except for the one no study condition. In the combined condition, thinking always preceded outlining.

The four experimental conditions of the repeated measures design were balanced across subjects. The practice trial consisted of reading, recalling, thinking, and outlining in order to familiarize the subjects with all subsequent procedures. During the actual test, the researchers only attempted to keep the subjects on task and provide neutral support, such as "you are doing fine."

The initial session lasted on the average 45 minutes, with a range of 30 to 70 minutes. Approximately one week later, 8 to 10 days, they were again

tested in the same room and asked to tell everything they could remember about "_____". The one word titles were used as cues for delayed recall.

The mixed design for the grade comparisons included two between-subject variables, grade (4 levels) by ability (2 levels), and two within-subject variables, passages (4 levels) by study type (4 levels). Since passages were nested in grade, passage effects will be noted but not discussed in detail here as there is no commonality across grades.

Scoring Procedures

Recall. Each subject's protocols, four at immediate test point and at delayed, or a total of 512 protocols, were analyzed. Scorers received typed transcripts of the protocols and were told to decompose the statements into binary content word units. The binary units were then classified as text propositions, text-entailed inferences, text-evoked statements, and external comments. Scorers also received abbreviated passage templates; an example of which is included in the appendix. Scorers were told to go through each protocol list isolating propositions that matched those of the passage. Only text propositions were included in the analyses for this study. Each passage proposition in the protocol was then given both a passage number and an hierarchical indice. Two scorers had to agree that the subject's response was a text proposition. This means that an average of .68 of the subjects' responses was not included in the analyses. A table of the response proportions classified into each of the four recall categories by grade and ability is included in the appendix. The frequency of text propositions and those at each hierarchical level as well as proportions of those available were used in subsequent analyses.

Order of Recall. Both the order of propositions recalled and their organization into propositional clusters were used to evaluate the order of recall.

Clusters were defined as two or more propositions that represented at least two hierarchical levels that were contiguous within the passage. For instance, in Resistance (Table 2), propositions 1.1 through 1.24 are considered to be one contiguous cluster. An hierarchical cluster of any of these 24 propositions would be scored as an order response. Any propositional cluster contains not only the information within the propositions but also the superordinate-subordinate relationships between propositions. The degree to which recall is expressed in hierarchical clusters is used as a speculative measure of the assimilation of the conceptual organization of the passage. The clusters were also scored for chronological order according to passage order.

The four-point scale for evaluating recall order is described below:

Ordered Clusters (4 points) - two or more clusters in passage order;

Unordered Clusters (3 points) - two or more unordered clusters;

One Cluster (2 points) - only one cluster; and

No Clusters (1 point) - no clusters, only isolated propositions or a collection of propositions at the same level. The last conditions suggest no memory for organization of passage ideas. A limitation of this qualitative scale is the difference between 3 and 4 points. It is much easier to imitate input order with two clusters than with ten. However, except for a few, less than .04 of the 512 protocols, the qualitative scale appeared appropriate.

Outlines. The 128 outlines, two for each subject, were analyzed in the same fashion as the recall protocols, with almost all propositions (over .90) mapped to a text proposition.

To ascertain the quality of outlines, a three point scale was devised:

Best (3 points) - major ideas covering all thirds of the passage and appropriate supporting details for each major idea;

Middle (2 points) - either covering all parts with no visual or verbal identification of major to supporting ideas or good major to supporting ideas but inadequate coverage of the passage; and Worst (1 point) - inadequate coverage of the passage and no identification of major to supporting ideas or repetitive entries of the same statements.

No criterion was established as to which idea should be the first most important idea versus second or third; any level 1 proposition was considered an acceptable major idea. There were no disagreements for 3 point outlines. Only 6 out of 128 resulted in disagreement for the two scorers as to whether the outlines should be given one or two points. The principal investigator's judgments were used for the six outlines.

RESULTS

The results section is divided into three parts, immediate recall, delayed recall, and comparisons between immediate and delayed recall. The general effects for grade and ability are followed by the trial effects due to study conditions, passages, and passage hierarchies where pertinent. Time taken to read and to study is included in order to describe the efficiency versus effectiveness of study upon retention. Order of recall is also included within each division.

The proportion recalled of the propositions available within each passage is used as the dependent measure in order to compensate for differences between number of passage propositions both within and across grades. The frequency results for propositions recalled are available from the author upon request.

Immediate Recall

The recall results have been divided into three separate analyses: (1) total proportions of passage propositions, (2) proportions of the three hierarchical levels, and (3) order of recall. Main effects for grade, ability, study, and passages are tabled whether significant or not. The only interactions that are reported are those significant at .05 or less for between subject effects and at .01 or less for treatment effects.

Insert Table 4 about here

The sums of squares for the nonsignificant interactions have been added to the sums of squares for the error term and the degrees of freedom to the degrees of freedom for the error term, which is why the error degrees of freedom changes in various analyses. (Note 1)

Total Recall. Able readers do retain more of the propositions than do the less able, a mean of .22 versus .11, but there are no significant differences by grade or by ability. The passages were selected from grade appropriate texts used in social studies and sciences classes rather than maintaining passage constancy across grades, so the passages increase in readability level. Though these readers did not recall significantly more propositions by grade, they did maintain approximately the same performance over more difficult texts. However, the pattern of means (Table 5) indicates that there is an increase in proportion recalled by grade for able readers

Insert Table 5 about here

through eleventh grade with a drop at the college level. The poorer readers

retain slightly less at higher grades until college. Thus, there is to some degree an increasing gap in information retained from school texts by reading ability at successive grade levels. The effect is mitigated by the smaller difference at the college level, where there was also less of a reading difference between the two groups.

Passages were also a substantial source for difference at immediate test point, means of .15 for science texts and .18 for social studies. Since passages were nested in grade, the only meaningful results for specific content are those of the individual grade analyses, (Note 1), where passages were a reliable source for differences ($p \leq .01$) in grades five and eleven, but not in eighth grade and college. The two science passages had fewer propositions recalled by both good and poor fifth and eleventh grade readers.

Study conditions had not taken place before recall and so no effect could take place unless the counter-balancing had not controlled for passage differences.

Hierarchical Levels. The analysis of the proportions available at each level of the hierarchy, I, II, and III, is the dependent measure for the following results. The findings for the hierarchical levels provides empirical support for the existence of a propositional hierarchy and its influence on recall. Level I of the hierarchy was more likely to be recalled than either levels II or III ($F=51.6$; 1,64 df; $p \leq .00$), while level II was more likely to be recalled than level III ($F=10.7$; 1,64 df; $p \leq .01$). The Scheffé test for mean comparisons (1963) was used for all complex effects involving more than two means. (Note 2) The content of passages influenced the amount recalled at the hierarchical levels with science level I propositions recalled at .22 and social study propositions at .29, level II at .17 and .19, and level III at .13 for both.

The ability by hierarchy interaction was due to the able readers recalling more propositions at each level, but particularly at level I, then at II, and the smallest difference by ability for level III. However, the average proportions by levels determined by the ratio of the levels to each subject's total recall show that the level I propositions were most memorable for both good and poor readers (.47 versus .49), level II next at .30 for both groups, and level III at .24 for able readers and .21 for the less able. Immediately after reading the chronological redundancy of arguments, a determining factor for hierarchical levels used in this study, did affect the memorability of propositions. All readers were more likely to recall level I propositions than levels II or III.

Order of Protocols. The four point qualitative scale used to assess order of protocols ranged from four points for a protocol that was clustered hierarchically and followed the order of passage propositions down to one point for protocols that were not ordered and had no hierarchical clusters. Able readers were more likely to use clusters and follow input order, a mean of 3.52 versus a mean of 3.16 for poorer readers. There was also a significant effect for grade. College students recalled in clusters and used input order more than any of the younger readers. The respective means are 3.34 for fifth grade, 3.11 for eighth, 3.21 for eleventh, and 3.69 for college students.

In summary, the major effects for immediate recall are that able readers remember more of the passage propositions of all kinds and also are most likely to cluster information and to maintain passage order in their recalls. Passages do make a difference, but harder passages as determined by the results depress the recall of both good and poor readers equally. The hierarchical levels proved useful in scoring responses, and though there were differences

in amount recalled to the levels by ability, both groups retained more level I propositions in their recall protocols than levels II and III.

Reading Time. A second measure, number of seconds taken to read each passage, was also recorded. The amount of time taken to read the passages does not vary significantly by grade, ability, or grade by ability. Able readers spent slightly more time reading, a mean of 115 seconds versus 112 seconds for the poorer readers. Only the able fifth grade readers spent less time reading, 91 seconds, than their less able classmate, who averaged 111 seconds. In the individual grade analyses, both fifth and eleventh graders do take longer to read the science passages than the social study passages. The passage contents did not influence the reading time of eighth graders and college students. When time taken to read is divided by number of propositions recalled, able readers at all grades make much more efficient use of their reading time, with a mean of 6.8 seconds reading time per proposition recalled versus a mean of 13.8 for the less able ($F=9.6$; 1,56 df; $p < .00$).

Delayed Recall

The results (Table 6) are reported for the same three analyses used in

Insert Table 6 about here

immediate recall: (1) total proportions of passage propositions, (2) proportions of the three hierarchical levels, and (3) order of delayed recall. Again all main effects are tabled, but only interactions that are significant at $\leq .05$ for subject effects and $\leq .01$ for treatment effects.

Total Recall. All subject factors, grade, ability, and grade by ability affected the retention of the available passage propositions over time, from

eight up to ten days. Good readers averaged .16 of the proposition available versus .07 for poorer readers. Recall increased with grade up to college where there was less text recall, .09 at fifth, .11 at eighth, .16 at eleventh, and .11 at college. The interaction effect for grade by ability is partially

Insert Table 7 about here

due to the fact that there is no change in proportion recalled by the less able readers across grades; the average of .07 does not change from fifth through college. The able readers, on the other hand, retain more of the propositions as they progress through school until college. The college students on the average do make fewer text statements, but the proportion of their recall to text entailed inferences is also smaller, .40 as compared with .47 for the other three grades combined.

Studying had a positive effect on retention of the total propositions available. Using Scheffé's test for mean comparisons any study helps retention over no study ($F=12.9$; 1.64 df; $p \leq .01$). The combined study type was somewhat better than think or outline ($F=3.4$; 1.64 df; $p \leq .25$), but it was not much better, nor was there any difference for think versus outline. Improved retention as a result of studying was a general effect across passages. More of the propositions available in social study passages were retained, .13, than those in science passages, .10. The loss from immediate recall was .05 for both types of texts. The possible interaction for study type by passages was tested in the individual grade analyses. None of the four tests proved significant. Study type did not differentially affect the different passage contents.

There was no interaction of study type with ability or grade by ability. However, the grade by study did show a trend toward difference ($F=1.6$; 3,64 df; $p \leq .10$). Because of this trend the individual grade by study type effects are reported here. The average proportions retained under the four study

Insert Table 8 about here

condition indicate the somewhat different patterns by the various grades. The breakdown by ability is included, though not significant in any analyses, because of the slightly different ability performances at fifth grade and college.

The main effect of study for fifth graders was slight ($F=2.1$; 3,42 df; $p \leq .10$). The text retention of most of the able fifth grade readers was improved by thinking about the text over the no study condition, but there were large individual differences. Outlining depressed performance of poor fifth grade readers, and the good readers were not aided much. Eighth grade performance did not change much as a result of studying ($F=.8$; 3,42 df; $p \leq .80$), though their mean performance shows an average gain of .04 over no study for both ability groups by the combined thinking about the text and outlining it. The eleventh grade study effect ($F=4.8$; 3,42 df; $p \leq .01$) was due to all readers retaining more when they wrote out their notes in the outlining and combined conditions. There are slightly different patterns by ability in the college effect ($F=3.8$; 3,42 df; $p \leq .05$). Thinking or writing were equivalent aids for the able college readers, but the less able needed to write their notes to improve performance.

Hierarchical Levels. The same patterns appear in proportions recalled of those available at the hierarchical levels at delayed recall as at immediate

recall. Level I is more likely to be recalled than either levels II or III

Insert Figure 1 about here

($F=34.3$; 1,64 df; $p < .00$); and level II is more likely to be recalled than level III ($F=11.4$; 1,64 df; $p < .01$). Able readers retain more at each level as compared with the less able readers. The ratio of the proportions recalled at each level to each subject's total recall across the hierarchy shows that the poorer readers do retain more of the high level propositions than those of the lower levels, .44 at I, .34 at II, and .22 at III, as compared with the markedly similar ratios for able readers, .45 at I, .33 at II, and .23 at III. This preference for the vertical macrostructure, that provided in the text, is exhibited in all grades by both ability levels.

The significant passage by hierarchy interaction is due to a higher retention of level I social study propositions (.20) than those of the science passages (.14). There is no difference for level III (.09), and slightly better retention of level II social study propositions over science (.14 to .12).

Order of Protocols. The clustering and ordering of propositions recalled deviated more from passage input at delayed test point than at immediate, means of 2.9 versus 3.3 for immediate recall. Able readers were again most likely to use clusters and to maintain passage order, a mean of 3.3 versus 2.5 for poorer readers. There were no substantial effects for grade, for grade by ability, or for passage.

Studying did effect order of recall. The mean comparison test by study type indicates that any study helps some to preserve input order over no

study ($F=4.9$; 1,64 df; $p \leq .20$). The minimal interaction of study type by grade ($F=2.1$; 9,183 df; $p < .04$) is due to changes in eleventh grade and college readers. Study type had almost no effect on order at fifth and eighth

Insert Table 9 about here

grade. Eleventh graders had less input order with thinking about the passage, but both eleventh graders and college students increased in their use of input order with outlining and combined study.

Outlining. What the subjects were doing while thinking cannot be directly examined, but the outlines can provide physical evidence as to how these readers were interpreting the directions used for both conditions. The ability involved was that of isolating major ideas and supporting details and not the technical aspects of outline format. The students wrote out their outlines rather than telling them to the investigator, and the time taken to prepare their answers was recorded.

The students did work on their responses. The average number of propositions recorded by grade outnumbered those recalled at immediate test point for

Insert Figure 2 about here

the less able readers and were approximately equal for able readers. For both ability groups number of propositions included in the outlines exceeded those recalled at delayed test point; thus most of the subjects were trying to do the task. The mean number of propositions included in the outlines increased by grade except for college, from 17.1 at fifth, 24.3 at eighth, 35.7 at

eleventh, and 32.0 at college ($F=5.5$; 1,56 df; $p < .00$).

The students prepared two outlines, one as the sole method of study and one after thinking about the passage. There was no significant effect for the two conditions on the quality of the outlines, scales values 1 (poor) to 3 (good). Grade influenced outline quality more than any other source ($F=15.7$; 1,56 df; $p < .00$) means of 1.66 for fifth, 2.09 for eighth, 2.78 for eleventh, and 2.59 for college. Ability did not substantially affect outline quality.

Insert Table 10 about here

At three of the four grades, the two ability levels performed approximately the same. Only able eighth graders wrote substantially better outlines than those of their less able classmates. The eighth grade difference and the reversal of the less able readers over that of the able readers at college were the main sources for the ability by grade effect on outline quality ($F=3.2$; 3,56 df; $p < .03$).

The grade effect on outline quality substantiates the depression in recall at delayed test point for fifth graders when outline was their sole method of study, Table 8. Very few fifth graders had an hierarchical pattern in their selection of major to supporting ideas. Many of them also repeated the same statements in their responses. There was greater variability in the eighth grade patterns as noted in the ability by grade effect. According to a teacher in the high school used for the eleventh grade sample, most tenth and eleventh graders received both instruction and practice in determining major ideas and supporting details. In any case, though ability differences were large for all recall measures at eleventh grade, there was no difference

on any measure for outlining--frequency, quality, or time. Some of the able college readers did not complete their outlines and covered only one or two passage sections, which may have been a reasonable response given the quality of the passages but did not meet the study instructions. Thus, the less able college readers on the average have higher scores for outline quality than the able readers.

Study Time. Study time results are quite similar to those of reading time. Neither grade nor ability significantly influenced the amount of time taken to study. Since the two trials for thinking and outline time did not differ significantly, all study time conditions were summed into a total time with text and divided by number of propositions retained at the delayed test. Able readers took less than half the time per proposition, a mean of 37 seconds per proposition versus 85 seconds for the poorer readers ($F=9.6$; 1,56 df; $p \leq .00$).

The efficiency versus effectiveness result is seen in the effects of study type on time per proposition ($F=5.7$; 3,186 df; $p \leq .01$). The means for study type are 36.2 seconds per delayed proposition for the no study, reading time only condition; 36.8 for think and read, a .02 increase in propositions recalled and only a .6 increase in study time per proposition, 78.7 for outline and read, and 91.9 for think, outline, and read. The mean comparisons indicate that read only (no study) is most efficient ($F=16.5$; 1,64 df; $p < .00$); that read and think is more efficient than read and outline and read and combined ($F=10.9$; 1,64 df; $p < .05$); and that the latter two do not differ significantly from one another ($F= .6$; 1,64 df; $p > .90$).

The means for total time with text and time per proposition by study conditions, Table 11, exhibit different patterns for the two ability groups

Insert Table 11 about here

though there are sizable individual differences for time within ability groups. These able readers, on the average, did spend more time studying, and the time was effective for them, particularly thinking about the text. Their average time per propositions was least under the thinking condition, where they made a .04 gain over no study. The additional time spent in outlining and the combined study does not improve their recall of text information to any great extent. For the poorer readers proportion recalled increased with amount of time spent, but no study was the most efficient condition for them in that they spent the least amount of time per proposition retained.

Immediate versus Delayed Recall

Text recall should diminish over time to an abstract macrostructure of the major ideas. The expectations are that fewer text propositions will be stated, particularly fewer of the less important ones, and that most of the propositions expressed at delayed recall will be those expressed at immediate recall.

Three measures were used here to examine more closely comparisons between immediate and delayed recall: (1) proportion retained at the delayed test was subtracted from the proportion mentioned at immediate recall for a loss score; (2) the number of propositions mentioned at immediate recall that were also stated at delayed recall were tabulated to examine carry-over effects; and (3) the number of new propositions included at the delayed test were analyzed for study effects.

Loss Scores. The average proportion lost over the 8 to 10 days for all propositions over all subject factors and treatment conditions was .05, a mean

of .17 down to a mean of .12. There were no differences due to ability, ability by grade, or to passages in amount lost. There was an effect for amount lost by grade with the elementary and secondary students maintaining their original text recall better than the college students ($F=5.6$; 3,56 df; $p \leq .01$), with mean loss scores of .05 for fifth and eighth graders, .03 for eleventh graders, and .10 for college students.

Studying did minimize the loss of text propositions over time ($F=3.7$; 3,189 df; $p < .02$). The loss was greatest with no study, a mean loss of .08, a loss of .06 with thinking, .04 with outlining, and a minimal loss of .03 with combined study. Study was more effective than no study in retaining text propositions ($F=12.1$; 1,64 df; $p \leq .05$). There were no substantial differences in the three types of study.

The loss of propositions at the three hierarchical levels differed from one another ($F=17.02$; 2,126 df; $p \leq .01$), a loss of .08 for level I, .05 for level II, and .04 for level III. The loss at level I was greater than that for levels II or III ($F=9.11$; 1,64 df; $p \leq .01$), and there was no reliable difference for the latter two. There were no significant effects for passages, passages by hierarchy, study by hierarchy, or by any of the subject factors on the loss scores.

Carry-Over Effects. Immediate recall was a powerful predictor of what propositions were retained later. On the average, two-thirds of the propositions recalled immediately were retained at the delayed test. There were no ability

Insert Table 12 about here

differences on this measure. Older students did have fewer propositions overlap

from immediate to delayed until college. Fifth graders repeated .72 propositions, eighth .69, eleventh .58, and college .65. Study also decreased the number of immediate propositions that appeared in delayed recall, with .74 for no study, down to .66 for thinking, .65 for outlining, and .59 for combined study.

New Delayed Propositions. New delayed propositions can be added either through study and/or elaboration of the information. Able readers produced on the average 6.9 new propositions, and the less able only 3.2 ($F=45.4$; 1,56 df; $p \leq .01$). Grade was also a source for difference ($F=10.5$; 3,56 df; $p \leq .01$). There was an increase in number from a low of 3.1 new propositions at fifth grade, 4.5 at eighth, 7.5 at eleventh, and down to 5.0 at college. The grade by ability effect ($F=3.8$; 1,56 df; $p \leq .02$) was due to the drop at both ability levels for the college students. Passages did not influence the addition of new propositions. Study conditions were a significant source for difference ($F=7.7$; 3,189 df; $p \leq .01$). Any type of study was better than no study ($F=54.8$; 1,64 df; $p \leq .00$), and the combined condition was somewhat more effective than the other two study types ($F=4.6$; 1,64 df; $p \leq .25$).

DISCUSSION

The expected findings were moderately well confirmed. Immediate retention of text propositions did not increase significantly with grade. Apparently the passages as sets represented somewhat equivalent demands on the readers' retention processes at each grade. Older able readers did remember more of the text until college, where the less able readers were not as disparate from the good readers in reading skills. At the delayed test the older readers did retain significantly more of the passage information except for the college readers. The older school age students have had more exposure to school

requirements to learn text information and may have had instruction in study strategies. The increased retention by grade is due to the consistently better performance by able readers; there is no change in average proportion recalled at the delayed test by the less able readers.

At least two conditions qualify this result of no significant difference by grade for immediate recall. First, the desired performance was known by the subjects before any measurement was taken, both through the instructions and the practice trial. Spontaneous memory for learning from text may be quite different by grade in school if learning the content rather than recall of text is the goal as older subjects have had more practice in reaching this goal. Second, the time lapse from beginning to read to recalling was never more than a few minutes, the average reading time was 113 seconds. The necessity for using mnemonic strategies was minimized by both the short time interval and the lack of any interference from subsequent reading.

More able readers at all grades did recall more text propositions, likely because their encoding skills are much more efficient and they have time to concentrate on the content (Lesgold and Perfetti, 1978). The lack of a significant difference by ability for reading rate is contrary to most rate results. Assuming these good readers were capable of reading faster than the poorer readers, they must have used their time to do more than just read the passages. They knew they were to be tested on recall of text information. The better readers could have adjusted their normal rate so that they could be more accurate. They could have re-read portions that confused them, or sections that they felt were particularly important, or even attempted to memorize key points. Rate flexibility is often cited as a measure of good reading.

Given the argument on flexibility of rate for reading purposes by able readers, if the time to read is limited to the pre-determined subject's natural pace rather than used as a measure, the able readers should be more affected than the less able. The smallest difference in total proportion recalled by ability was for the fifth grade sample, where the good readers did not take more time to read.

The able school age readers improved their performance on almost all retention measures until college. One possible reason for the smaller proportion recalled at the college level has been suggested in the smaller ratio of text recall to their text entailed recall as compared with the other grades. Perhaps, students by this time are so accustomed to reading for ideas that they assimilate text information into their prior knowledge stores constructing representations that contain few veridical propositions. But the college students did preserve input order more than any other grade at immediate test point, which suggests greater attention to or at least memory for the organization of the information. It is also possible that the ratio of content difficulty to reading level was greater in the college texts. Whatever the reason for the college differences, as one reader described them, there is a "tilt" at this level; the college readers did not follow the pattern.

Passages were a significant source for difference in amount recalled, a fact which may be due to the manner in which the passages were written, "the arrangement of the propositions in the text base" (Miller & Kintsch, 1980, p.248), separate from selection of polysyllabic words and sentence length. It could also be the ratio of new information within passages to the readers' prior knowledge stores. In the Miller and Kintsch study, one paragraph required knowledge of the person's background to be coherent. Reading time

increased and amount of recall was lessened for this paragraph. The assumed cause of the lower performance was the lack of appropriate prior information to comprehend the text. In the study described here, reading time was longer and recall was less for the fifth and eleventh grade science passages. There were no passage by ability interactions. Both able and less able readers were similarly affected by passage difficulty, but the cause of the difficulty could be either the content or the manner of writing.

Though able readers retained more of the propositions at each hierarchical level, the importance of the top level structure for readers at all grades and both ability levels was also confirmed. As described earlier, the passage hierarchies were determined by dual decision rules with independent clauses dominating over dependent and with new propositional information raised over repeated or elaborated information. The passage importance of the propositions appears to be an attribute of the text to which all readers respond. It may be that readers do not have to process all of the text to pick up the major ideas and that a few repeated arguments are sufficient for stating many of the level I propositions. The introductory topic information presented in initial clauses is often quite general and is sometimes repeated throughout the text. In any case, the retention of the major propositions was not a function of reading ability for these subjects; the ability differences were quantitative not qualitative.

On the other hand, reading ability did influence the order of recall. A closer examination of the clustering aspects of text propositions in recall might prove to be a better measure of understanding than retention of major ideas. The ability to relate the subordinate details to the appropriate superordinate ideas would indicate an appreciation of the conceptual organization

of the passages.

The finding that study makes more of a difference than passages on retention of propositions was consistent for all recall measures including order of recall. Since there were no interactions with passages, study effects may be generalized to text learning situation. However, one series of studies is not sufficient for this conclusion. Any of the types of study did help retention, but the abler readers made more efficient use of their study time. Fewer immediate recall propositions were carried over into delayed recall after studying and more new propositions were added. Apparently the subjects did attend to ideas that they had not previously recalled during study time.

The directions for study were the same for all conditions. The requirement to integrate major ideas with appropriate supporting statements counteracted the tendency to abstract the content into major ideas only. Most of the recall protocols contained at least one hierarchical cluster, and clusters, by definition, include propositions at two or more levels. A higher proportion of the lower level propositions were maintained from the immediate to the delayed tests than level I propositions.

Only extensive study time aided the poorer readers, and even then they were not helped much. More precise instructions, perhaps instructions that are passage specific, might help poorer readers to attend to the organization of the ideas. The lower ability readers as a group did not improve in their retention of the text information. They need help, but what type of help is a major question. Also, studying was more effective at eleventh grade and college for both retention and order of recall. The younger students likely did not know how to use this time to cluster information and to add missing links. They also may not have been able to monitor their own performances at immediate recall.

The underlying purpose for these studies was to seek differences by ability and age in processing text and retaining information in order to guide instruction for aiding younger and less able students. The major differences were quantitative--the good readers remembered more. The hierarchical analysis appears to be a feature of texts to which both able and less able readers respond even though the passage hierarchies were based on heuristic decisions. Thus, the hierarchical results did not distinguish between good and poor readers. However, the results for the other two qualitative measures, outlining and order of recall, did show different patterns by age or by ability. Older students were more capable in identifying the superordinate-subordinate conceptual organizations in their written responses, and the act of writing seems to have aided their retention of passage information. More able readers at all grades consistently maintained passage input order better than their less able peers. The clustering component of the scale used for measuring order of recall may prove to be a useful measure in the hunt for qualitative differences in ability that could be ameliorated by instruction.

NOTES

1. The frequencies upon which the proportions are based are available from the author upon request. The total proportional analyses include the sum of all text propositions recalled by each subject including the connective propositions divided by the total propositions available within each passage. The hierarchical analyses included the level I propositions recalled by each subject for each passage divided by the total level I propositions available in the passage. The same procedure was followed for level II and level III propositions.

A second type of proportional analysis of the hierarchies used each subject's own total as the denominator in order to examine macrostructure recall. The latter results were not significantly different by either grade or ability and the ANOVAs are not reported but are available upon request.

The main effects for grade, ability, study type, and passages are always reported whether significant or not. Interaction effects are only reported where significant. Alpha was set at .05 for between subject effects and at .01 for trial effects. Only interactions that met these alpha levels are reported.

The omega square (w^2), the proportion of the variance accounted for by a particular source, is based on the partition sum of squares in which the source resides. The partition sum of squares is the sum of all the sources including that for the error term. The immediate recall proportions for the three hierarchical levels is used below as an example. The design is 64 subjects by four trials by three measures or $64 \times 4 \times 3 = 768$ data points.

Partition Source	Sum of Squares	df	Porportion of Total SS
Between	7.93	63	.46
Trials	3.87	192	.23
Measures	2.94	128	.17
Trials x Measures	2.36	384	.13
TOTAL	17.11	767	1.00

There are interesting differences in the proportionate size of the various partitions across analyses, tabled in appendice 3. For immediate recall the between partition accounts for .46, the largest partition, but in the delayed loss score the trials partition is the largest source, .46, indicating a different weighting for canonical partitions upon the total sum of squares.

Both study type and passages are within the trials partition. The effects of each and their respective interactions with subject factors where significant are subtracted from the partition sum of squares; the remainder is used as the error term SS. This sum is then divided by the 192 df for trials minus the df for passage, study type, and any significant interactions. The result is the mean square error term used in the F tests.

The study type by passage interaction was examined in the individual grade analyses and was never significant, but it was a weak test with only four subjects in each cell. Study type could not have any effect on immediate recall as study had not occurred yet, and it was expected that the effects of passages would not change from immediate to delayed test points. All results seem to substantiate the lack of a study type by passage interaction, but obviously other designs could test this question more rigorously.

Pooling the interaction sums of squares into the error term can be a dubious procedure (Winer, 1962). If there is a sizeable interaction, though nonsignificant at the preestablished alpha level, pooling inflates the size of the error term and "introduces a negative bias to the F test," (Keppel, 1973, p. 560). On the other hand, if the interactions are minimal, then there is an increase in power for the F test since the df for the denominator are increased.

Pooling was used to examine the contrast between the random effects of passages across grades versus the fixed study type effects, both of which were embedded in the trials partition. The controls used for pooling were two-fold: (1) all treatment interactions with $p > .05$ were pooled, and (2) all passage by grade effects were pooled since their interpretation would be meaningless. The resulting F values for significant effects sometimes increased and sometimes decreased, but in no case were the preset alpha values of the omnibus F exceeded.

2. The Scheffé test (1953) was used for all mean comparison tests where there were more than two means: study type, hierarchies, or interactions with these two sources. The Scheffé ratio is the same as the ratio for orthogonal comparisons:

$$F = \frac{(c_1)(\bar{x}_1) + (c_2)(\bar{x}_2) + \dots + (c_n)(\bar{x}_n)^2}{MS_{\text{error}} \left(\frac{(c_1)^2}{n_1} + \frac{(c_2)^2}{n_2} + \dots + \frac{(c_n)^2}{N_n} \right)}$$

Scheffé sets the value for the prespecified alpha level at the number of comparisons made times the tabled F:

For study type, F at .05; 3,64 df; = $2.76 \times 3 = 8.28$, and

F at .01, 3,64 df; = $4.13 \times 3 = 12.39$;

For hierarchy, F at .05; 2,64 df; = $3.15 \times 2 = 6.30$, and

F at .01; 2,64 df; = $4.98 \times 2 = 9.96$.

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Table 1
Subject Description by Grade and Ability

Grade/Ability	Mean	s.d.	Test	Type Score
Fifth/High	93	3.4	SRA	National Percentile
Fifth/Low	54	23.8	SRA	National Percentile
Eighth/High	94	4.8	SRA	National Percentile
Eighth/Low	35	14.4	SRA	National Percentile
Eleventh/High	>90	x	CTBS	National Percentile
Eleventh/Low	<35	x	CTBS	National Percentile
College/High	91	10.0	Nelson Denny	Raw Score
College/Low	71	10.3	Nelson Denny	Raw Score

xCounselors selected students and stipulated high ability were 90th percentile or above and low ability were 35th percentile or below.

Table 2
Propositional Analysis for Resistance, Sentences One and Two

Chronological Number	Proposition	Hierarchical Indice
1.1	(LOC: in, 1.9, devices)	2
1.2	(QUALITY OF, 1.1, electrical)	3
1.3	(QUALITY OF, 1.1, heating)	3
1.4	(CONN: such as, 1.5, 1.6, 1.7)	c
1.5	(ISA, 1.1, grills)	4
1.6	(ISA, 1.1, toasters)	4
1.7	(ISA, 1.1, flatirons)	4
1.8	(CONN: and, 1.5, 1.6, 1.7)	c
1.9	(DO, I: element, G: heat)	1
1.10	(ISA, element, wire)	1
1.11	(CONN: or, 1.10, 1.12)	c
1.12	(ISA, element, ribbon)	1
1.13	(QUALITY OF, heat, actual)	2
1.14	(QUALITY OF, wire, resistance)	2
1.15	(QUALITY OF, resistance, high)	3
1.16	(QUALITY OF, ribbon, resistance)	2
1.17	(make, A: ?, G: wire, S: alloy)	2
1.18	(make, A: ?, G: ribbon, S: alloy)	2
1.19	(QUALITY, make, usually)	3
1.20	(QUALITY OF, alloy, nickel)	3

Table 2 (cont)

1.21	(QUALITY OF, alloy, chromium)	3
1.22	(QUALITY OF, alloy, iron)	3
1.23	(CONN: and, 1.20, 1.21, 1.22)	c
1.24	(CONN: such, 1.23, 1.25)	c
1.25	(provide, S: alloy, g: resistance)	1
1.26	(LOC: in, 1.25, space)	2
1.27	(QUALITY OF, space, compact)	3
1.28	(QUALITY, resistance, necessary)	2
1.29	(CONN: and, 1.25, 1.31, 1.34)	c
1.30	(melt, E: alloy)	1
1.31	(NEG: not, 1.30)	1
1.32	(CONN: or, 1.31, 1.34)	c
1.33	(oxidize, E: alloy)	1
1.34	(NEG: not, 1.33)	1
1.35	(DEGREE: melt, much)	2
1.36	(DEGREE: oxidize, much)	2
1.37	(QUALITY, much, very)	3
1.38	(TIME: at, 1.39)	2
1.39	(attain, E: alloy, G: temperature)	2
1.40	(QUALITY, temperature, high)	3

Table 3

Passage Descriptions by Grade Levels
(four at each grade level)

Grade	Fry m (range)	# Words m (range)	# Sentences m (range)	# Propositions m (range)	Hierarchical Propositions I,II,III
Fifth	5.1 (4.6-6.1)	239 (225-248)	20 (16-24)	116 (111-123)	.21,.32,.36
Eighth	7.9 (7.7-8.5)	263 (252-275)	15 (12-18)	126 (108-138)	.19,.36,.32
Eleventh	10.2 (9.7-10.4)	252 (245-258)	13 (11-14)	125 (115-135)	.18,.36,.35
College	13.0 (11.1-14.5)	257 (249-267)	12 (8-15)	126 (116-139)	.19,.32,.41

Table 4

ANOVAS for Immediate Recall Dependent Measures

Source	SS	df	F	p	η^2
Total Proposition Proportions					
Between					
Grade	.10	3	1.4	.25	.02
Ability	.77	1	33.4	.00	.57
error	1.29	56			
Trials					
Study Type	.00	3	.0	.97	.00
Passages	.05	3	3.0	.03	.03
error	1.11	186			
Hierarchical Level Proportions					
Between					
Grade	.38	3	1.6	.20	.03
Ability	2.70	1	34.2	.00	.33
error	4.43	56			
Trials					
Study Type	.00	3	.0	.96	.00
Passages	.22	3	4.2	.01	.04
error	3.65	186			

Table 4 (cont)

Measures

Hierarchy	1.92	2	124.6	.00	.65
HierxAbil	.09	2	6.1	.00	.03
error	.92	124			

Trials x Measures

PassxHier	.32	6	10.9	.00	.13
error	2.04	378			

Order of Immediate Recall

Between

Grade	12.07	3	5.7	.00	.16
Ability	7.91	1	11.2	.00	.11
error	39.67	56			

Trials

Study Type	.67	3	.4	.78	.00
Passages	3.79	3	1.8	.15	.00

Table 5
Average Immediate Recall Proportions by Grade and Ability

Grade/Ability	Total		Level I		Level II		Level III		Order	
	m	s.d.	m	s.d.	m	s.d.	m	s.d.	m	s.d.
Fifth/High	.18	.12	.27	.19	.20	.13	.12	.10	3.5	.86
Fifth/Low	.11	.07	.17	.13	.12	.09	.08	.04	3.2	1.03
Eighth/High	.21	.12	.31	.20	.22	.11	.18	.13	3.5	.76
Eighth/Low	.10	.07	.16	.14	.11	.08	.07	.07	2.8	1.16
Eleventh/High	.28	.14	.38	.18	.27	.15	.25	.14	3.4	.55
Eleventh/Low	.09	.05	.15	.09	.09	.06	.07	.07	3.1	.98
College/High	.23	.14	.35	.19	.24	.13	.18	.14	3.7	.63
College/Low	.15	.06	.23	.11	.17	.08	.11	.06	3.7	.55

Table 6

ANOVAS for Delayed Recall Dependent Measures

Source	SS	df	F	p	w^2
Total Proposition Proportions					
Between					
Grade	.15	3	4.3	.01	.08
Ability	.56	1	48.9	.00	.35
GradexAbil	.14	3	4.0	.01	.07
error	.64	56			
Trials					
Study Type	.07	3	4.8	.00	.06
Passages	.04	3	2.8	.04	.02
error	.89	186			
Hierarchical Level Proportions					
Between					
Grade	.51	3	4.3	.01	.08
Ability	1.93	1	49.1	.00	.36
GradexAbil	.42	3	3.6	.02	.06
error	2.21	56			
Trials					
Study Type	.28	3	6.1	.00	.07
Passages	.19	3	4.0	.01	.04
error	2.92	186			

Table 6 (cont)

Measures

Hierarchy	.88	2	98.0	.00	.57
HierxAbl	.10	2	10.7	.00	.06
error	.56	124			

TrialsxMeasures

PassxHier	.14	6	7.9	.00	.10
error	1.13	378			

Order of Delayed Recall

Between

Grade	4.1	3	1.0	.42	.00
Ability	39.1	1	27.1	.00	.30
error	80.7	56			

Trials

Study Type	11.7	3	3.3	.02	.02
Passages	5.8	3	1.6	.20	.01
StudyxGrade	20.4	9	2.1	.04	.0
error	204.0	177			

Table 7

Average Delayed Recall Proportions by Grade and Ability

Grade/Ability	Total		Level I		Level II		Level III		Order	
	m	s.d.	m	s.d.	m	s.d.	m	s.d.	m	s.d.
Fifth/High	.12	.10	.20	.16	.14	.19	.07	.06	3.2	.94
Fifth/Low	.07	.06	.10	.10	.08	.08	.05	.04	2.2	1.39
Eighth/High	.16	.10	.23	.16	.17	.10	.13	.12	3.3	.92
Eighth/Low	.07	.06	.09	.09	.10	.08	.06	.06	2.3	1.23
Eleventh/High	.24	.10	.33	.13	.25	.12	.21	.11	3.3	.58
Eleventh/Low	.07	.05	.13	.09	.07	.06	.06	.06	2.6	1.29
College/High	.14	.10	.19	.13	.17	.12	.10	.10	3.3	1.03
College/Low	.07	.06	.11	.11	.09	.07	.05	.06	2.8	1.48

Table 8

Delayed Proportions for Study Conditions by Grade and Ability

Grade/Ability	No Study		Think		Outline		Combined	
Fifth/High	.08	.03	.16	.16	.10	.06	.13	.08
Fifth/Low	.07	.06	.07	.07	.04	.04	.08	.07
Eighth/High	.15	.13	.14	.09	.15	.06	.19	.13
Eighth/Low	.05	.06	.07	.06	.07	.04	.09	.08
Eleventh/High	.22	.11	.21	.12	.28	.11	.26	.05
Eleventh/Low	.04	.03	.05	.04	.08	.05	.12	.06
College/High	.08	.05	.17	.13	.17	.10	.13	.07
College/Low	.04	.06	.04	.03	.11	.06	.10	.06

Table 9
Average Order of Delayed Recall by Grade and Study Type

Grade	No Study		Think		Outline		Combined	
	m	s.d.	m	s.d.	m	s.d.	m	s.d.
Fifth	2.8	1.2	2.9	1.1	2.7	1.3	2.7	1.1
Eighth	2.7	1.4	3.0	1.2	2.9	.8	2.8	1.1
Eleventh	2.8	.9	2.3	.9	3.2	.8	3.6	.5
College	2.4	1.2	1.8	1.4	3.5	.8	3.6	1.1

Table 10
Outline Quality by Grade and Ability

	Fifth		Eighth		Eleventh		College	
	High	Low	High	Low	High	Low	High	Low
Mean	1.75	1.56	2.44	1.75	2.81	2.75	2.38	2.81
s.d.	.79	.73	.64	.74	.53	.44	.72	.41

Table 11

Average Time with Text and Time per Proposition by Ability
for Study Conditions

		No Study		Think		Outline		Combined	
		High	Low	High	Low	High	Low	High	Low
Time with Text									
(seconds)	m	119	115	195	183	559	513	645	594
	s.d.	77	48	109	59	287	189	318	193
Time per Proposition									
(seconds)	m	26	46	19	54	45	111	60	123
	s.d.	82	47	34	58	55	157	135	173

Table 12

Proportion of Delayed Propositions that were Recalled
Immediately by Grade and Study Type

Grade:	Fifth	Eighth	Eleventh	College
No study	.74	.78	.67	.77
Think	.77	.67	.56	.66
Outline	.71	.65	.61	.63
Combined	.67	.66	.49	.56

Appendix A

Scoring Sheet for Resistance, Propositions 1.1-1.23

<u>Number</u>	<u>Indice</u>	<u>Content</u>
1.1	II	in devices
1.2	III	electrical devices
1.3	III	heating devices
1.4	c	such as devices
1.5	III	grills devices
1.6	III	toasters devices
1.7	III	flatirons devices
1.8	c	grills or toasters
1.8	c	grills or flatirons
1.8	c	toasters or flatirons
1.8	c	grills, toasters, or flatirons
1.9a	I	element consist of
1.9b	I	consists of heat
1.9c	I	heating element
1.10	I	element is wire
1.11	c	wire or ribbon
1.12	I	element is ribbon
1.13	II	actual heat
1.14	II	resistance wire
1.15	III	high resistance
1.16	II	resistance ribbon

Appendix A (cont)

<u>Number</u>	<u>Indice</u>	<u>Content</u>
1.17	II	wire made of
1.17	II	alloy made of
1.18	II	ribbon made of
1.19	III	usually made of
1.20	III	alloy is nickel
1.21	III	alloy is chromium
1.22	III	alloy is iron
1.23	c	nickel and chromium
1.23	c	nickel and iron
1.23	c	chromium and iron
1.23	c	nickel, chromium, and iron

Scorers would label the protocol scoring sheet with the number and the indice by each veridical proposition. If the scorer was not certain, there was a third column for a ?.

Appendix B

Proportions of Subject Responses Classified into the Four Recall Categories by Grade and Ability

Grade Ability	Fifth		Eighth		Eleventh		College	
	High	Low	High	Low	High	Low	High	Low
Immediate Recall								
Text	.52	.40	.35	.20	.39	.16	.45	.31
Text Entailed	.27	.23	.35	.30	.37	.27	.40	.31
Text Evoked	.07	.21	.13	.30	.09	.27	.09	.21
External	.14	.16	.17	.20	.15	.30	.08	.17
Total Words	107	73	141	86	151	81	125	112
Delayed Recall								
Text	.42	.37	.30	.12	.30	.08	.31	.28
Text Entailed	.33	.25	.39	.38	.34	.18	.50	.28
Text Evoked	.11	.23	.15	.32	.12	.45	.11	.31
External	.14	.15	.16	.19	.24	.29	.08	.20
Total Words	83	52	115	69	142	87	107	85

Appendix C

Canonical Partitions of the Sums of Squares

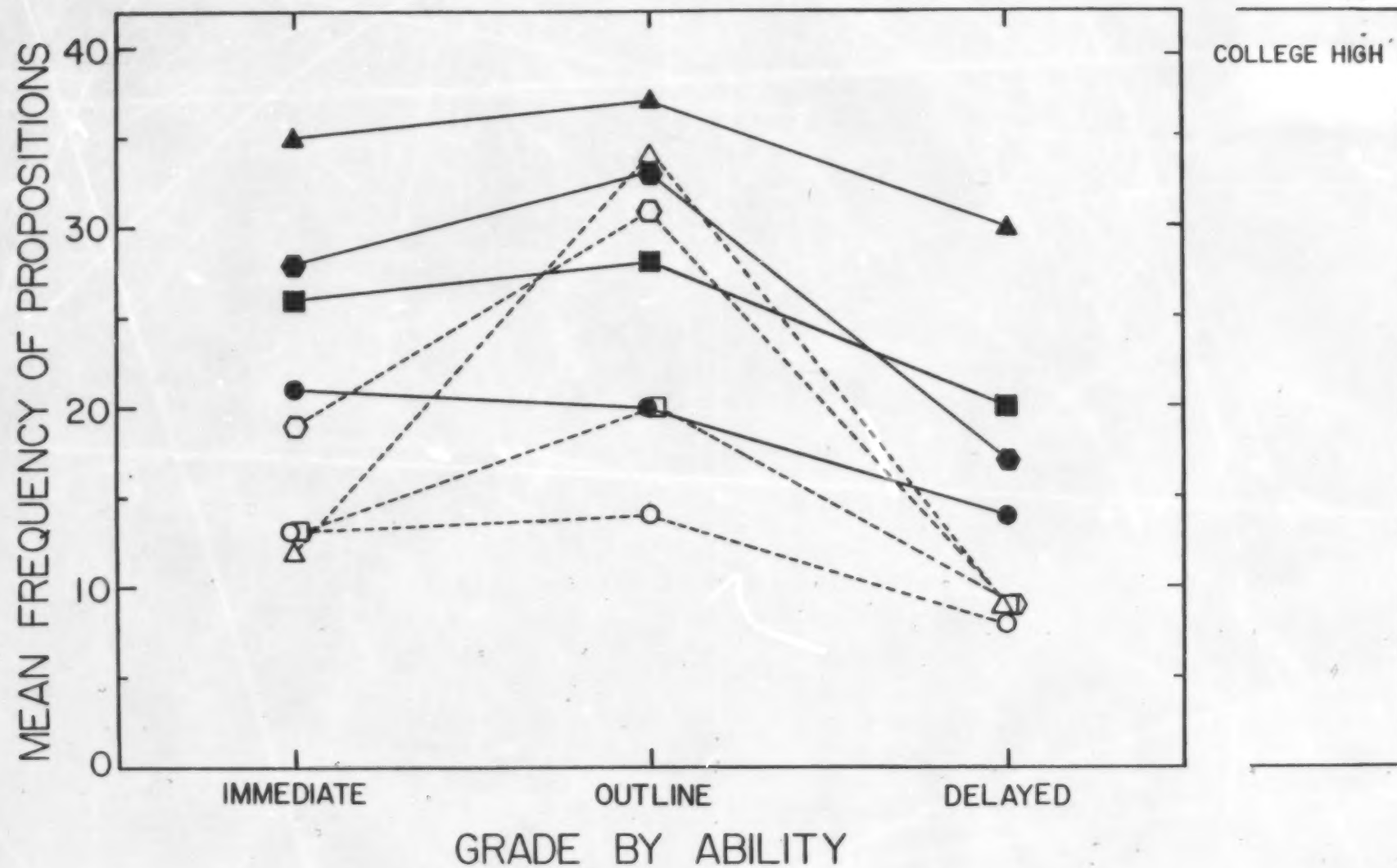
IMMEDIATE RECALL

Partition	Total Proportion			Hierarchy			Order		
	SS	df	%	SS	df	%	SS	df	%
Between	2.3	63	.66	7.9	63	.46	63	63	.33
Trials	1.2	192	.34	3.9	192	.23	126	192	.67
Measures				2.9	128	.17			
Trials x Measures				2.4	384	.14			
TOTAL SS	3.5	255	1.00	17.1	767	1.00	189	255	1.00

DELAYED RECALL

Partition	Total Proportion			Hierarchy			Order		
	SS	df	%	SS	df	%	SS	df	%
Between	1.5	63	.60	5.1	63	.45	126	63	.34
Trials	1.0	192	.40	3.4	192	.30	242	192	.66
Measures				1.5	128	.13			
Trials x Measures				1.4	384	.12			
TOTAL SS	2.5	255	1.00	11.4	767	1.00	368	255	1.00

Partition	Outline Quality			IMM - DEL Total			IMM - DEL Hierarchy		
	SS	df	%	SS	df	%	SS	df	%
Between	59.9	63	.75	.6	63	.30	1.9	63	.21
Trials	20.0	64	.25	1.3	192	.70	4.4	192	.46
Measures							1.1	128	.12
Trials x Measures							2.0	384	.21
TOTAL SS	79.9	127	1.00	1.9	255	1.00	9.5	767	1.00



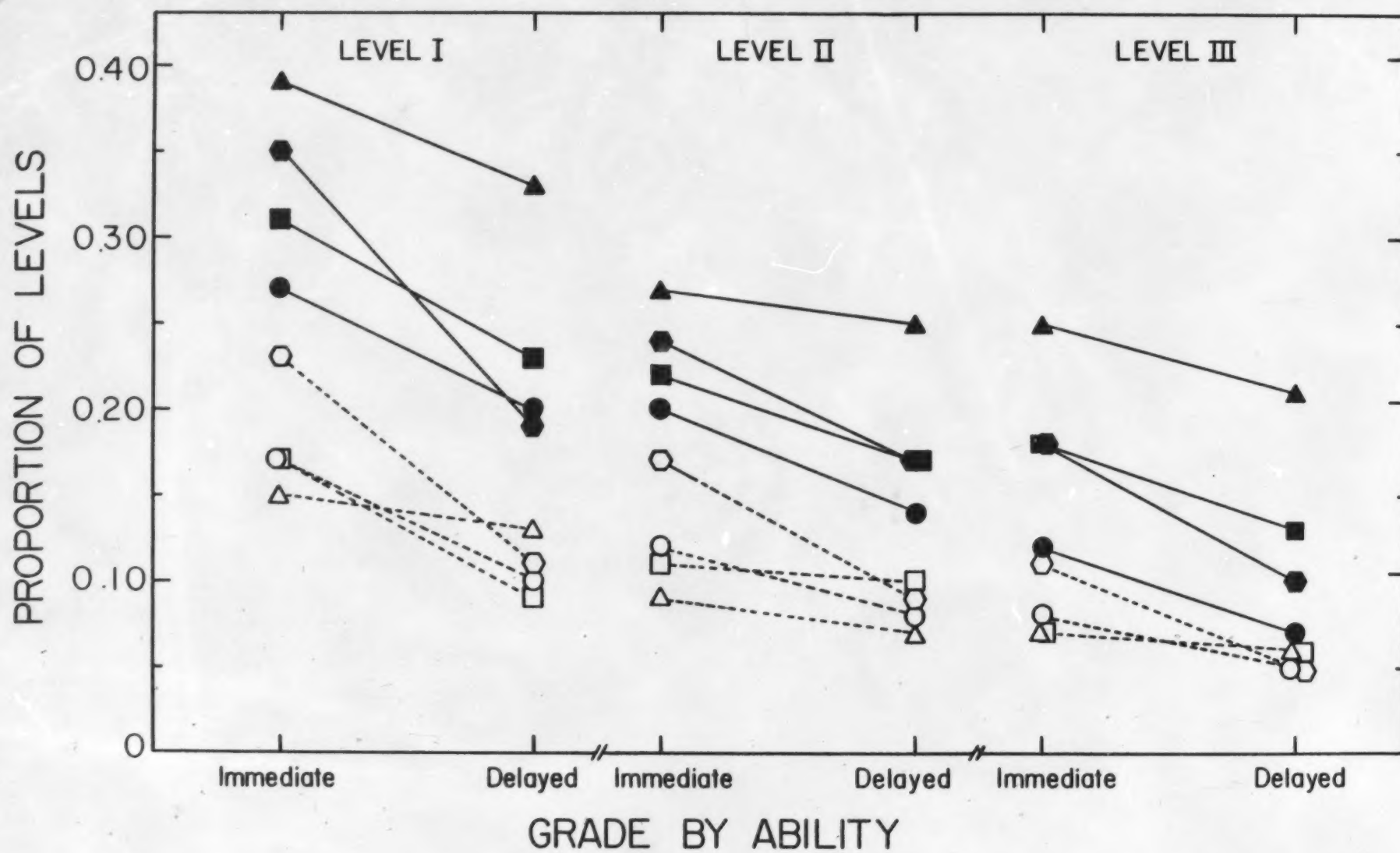


FIGURE CAPTIONS

Figure 1. Proportion of the Three Hierarchical Levels at Immediate and Delayed Test Points by Grade and Ability.

● = fifth, high; ○ = fifth, low; ■ = eighth, high;
□ = eighth, low; ▲ = eleventh, high; △ = eleventh, low;
● = college, high; ○ = college, low.

Figure 2. Number of Propositions Stated at Immediate and Delayed Recall and in Outlines by Grade and Ability.

● = fifth, high; ○ = fifth, low; ■ = eighth, high;
□ = eighth, low; ▲ = eleventh, high; △ = eleventh, low;
● = college, high; ○ = college, low.